

5. *Observations on the Food-Cycle of the South African Stockfish, Merluccius capensis* Cast. off the West Coast of South Africa; with a Note on the Food of the King-Klip *Genypterus capensis* (Smith).—By J. M. RATTRAY, M.Sc., Low Temperature Research Laboratory, Cape Town.

(With 2 Text-figures.)

(MS. received 1945.)

THE observations recorded in this paper were made during a bacteriological investigation of a serious outbreak of spoilage in various canned stockfish products. The bacteria which were ultimately found to be responsible for the spoilage were traced back to the fish on the trawler, and eventually the evidence suggested that the fish actually left the water in an infected condition. As a result of this it was thought that a study of the food-cycle of the stockfish might throw some light on the primary source of infection.

The South African stockfish *Merluccius capensis* Cast. is apparently very similar morphologically to the Northern Atlantic form *M. vulgaris*, commonly known as hake, and may even be identical with it. The question, however, has not yet been satisfactorily settled, and at present *M. capensis* is regarded as a distinct species. Although it is one of the most important commercial fishes of South Africa and forms the bulk of the fish trawled round the coast of this country and half of the total fish harvest, no information has been published regarding its life-history, feeding habits, etc. Barnard (1) says of the stockfish: "It is very abundant at times, but seems to be uncertain in appearance. Like the Northern form, they probably migrate considerable distances, both for purposes of spawning and also from one food-ground to another." According to Gilchrist (2) their chief food seems to be one particular species of Macrurid, viz., *Macrurus fasciatus*. This appears to be the only first-hand reference there is on the subject.

It must be stressed again that the data presented here were obtained during the course of a *bacteriological* examination of the foodstuffs in the stomach of the stockfish and that it was not intended to make a comprehensive and independent study of this aspect of

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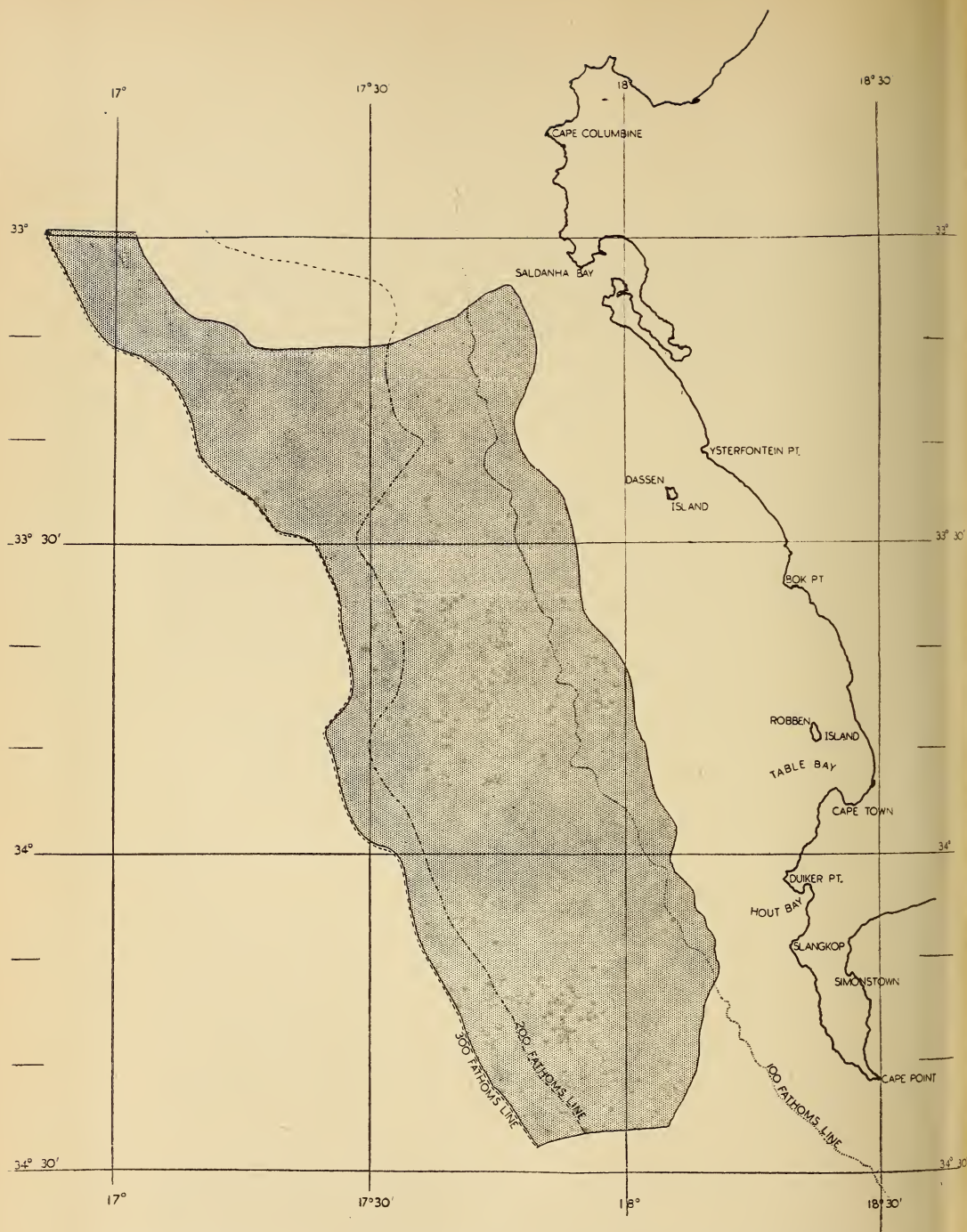


FIG. 1.—Showing the trawling grounds (shaded area) from which the stockfish were obtained.
(Taken from Division of Fisheries Analytical Chart, No. 1, 1931.)

DIFFERENT SIZE GROUPS.

Organisms Found.



33°

33° 30'

34°

34° 30'

<i>Sebastes</i> (Jacoever).	Fish remains (unidentifiable).	<i>Solenocera</i> or <i>Funchalia</i> (Prawns).	Prawn-like crustacean remains (unidentifiable).	<i>Parapagurus dimorphus</i> (Hermit Crabs).	Starfish or Polychaeta.	Sea-anemones.
..	..	1				
1	..	1	1			
..	2	2	1			
1	1	1	1	..	1	
..	3	1	2			
..	2	..	..	1		
..	1	..	1	..	1	
..	3	1				
..	4	1				
..	3					
..	4	1		
..	1	1
..	1		
..	3					
..	1	
..	1			1
..	1	1	..	2
..	1	..	1
..	2
..	1					
2	31	8	6	4	4	7

ing the table especially where organisms

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the natural history of the fish. The observations were made over a period of about 18 months and involved the examination of some 1450 stomachs of fish trawled from the main Atlantic fishing grounds. No fish from the Indian Ocean were examined.

The fish, which were obtained through the courtesy of Messrs. Irvin and Johnson, were trawled from what are known as the North fishing grounds that lie roughly between lat. 33° S. and $30^{\circ} 30'$ S. and long. 17° E. and $18^{\circ} 10'$ E., and the depth of this area varies between 100 and 300 fathoms (see fig. 1). Depending on circumstances, the trawlers usually stay on the grounds three or four days, returning to port twice a week to land the fish. When conditions permitted, a small sample of between 12 and 18 fish in the round state and selected as being representative of the usual commercial sizes was sent to this laboratory for examination.

According to existing legislation (3) it is not permissible to catch or offer for sale stockfish under 20 inches in length, and the size of the trawl mesh is presumably laid down so as to ensure this. In practice, however, it is apparent that a considerable number of fish below 20 inches are caught, and there is evidence to show that only fish under 12 inches escape, while fish from 12 to 19 inches are caught in ever-increasing quantities (4). The few fish under 12-13 inches which were examined were obtained from the stomachs of larger fish.

THE MAIN FOOD OF THE STOCKFISH.

At least 19 different organisms were removed from the stomachs at various times throughout the 18 months, but it soon became apparent which of these constituted the main food of the fish and which were mere casual items of diet. Undigested organisms found in the mouth have been disregarded, as the stockfish presumably behaves like the hake and snatches at anything which may be present in the trawl while being pulled to the surface.

Table 1 shows the different types of organisms which were found in the stomachs of fish of different size groups.

The number of stomachs examined includes those that were found empty. When several different organisms were present in the same stomach, each organism is recorded as having been found once. The frequency of occurrence is given as the actual number of times the organism was found and not as a percentage, as this is misleading in the size groups where only a few stomachs were examined.

Table 2 shows the monthly distribution of the various types of organisms recovered.

TABLE 1.—SHOWING FOOD PRESENT IN STOMACHS OF FISH OF DIFFERENT SIZE GROUPS.

		Frequency of Occurrence.																
Size Group of Fish (in inches).	No. of Stomachs Examined.	Main Food of Stockfish.						Other Organisms Found.										
		Mysids and/or Euphausiids.	<i>Myctophum</i> and/or <i>Neurorticus</i> .	<i>Merluccius capensis</i> (Stockfish).	Macrurids (mostly <i>Coelorhynchus fasciatus</i>).	Cephalopods (mostly <i>Loligo</i> sp.).	<i>Trachurus trachurus</i> (Masbankers).	<i>Scomber colias</i> (Mackerel).	<i>Photichthys argenteus</i> .	<i>Halitolenus maculatus</i> (Sancord).	<i>Tripterygius gilchristi</i> (Gilchrist's Triplefin).	<i>Sebastes</i> (Jacopever).	Fish remains (unidentifiable).	<i>Solenocera</i> or <i>Funchalia</i> (Prawns).	Prawn-like crustacean remains (unidentifiable).	<i>Parapagurus dimorphus</i> (Hermit Crabs).	Starfish or Polychaeta.	Sea-anemones.
9½ and under																		
10-10¾	3	3	2															
11-11¾	2	2																
12-12¾	3	..	1															
13-13¾	9	7	3															
14-14¾	11	4	6	..	..	1												
15-15¾	22	8	5	..	..	..	..	..	..	..	..	..	..	1				
16-16¾	43	19	5															
17-17¾	64	25	8	..	1	1	..	..	..	..	..	..	..	..	1			
18-18¾	95	42	20	1	1	7	..	..	..	..	1	..	..	1				
19-19¾	138	56	36	..	4	6	..	..	..	..	..	2	2	2	1			
20-20¾	171	68	35	1	3	12	..	1	..	..	1	1	1	1	1	..	1	
21-21¾	125	42	28	3	4	5	..	..	2	..	..	3	1	2				
22-22¾	74	22	18	..	1	2	..	..	..	..	..	2	..	..	1			
23-23¾	82	21	17	2	4	3	..	..	..	..	..	1	..	..	1		1	
24-24¾	65	18	8	3	2	2	..	1	..	..	..	3	1					
25-25¾	54	10	6	2	5	3	..	..	..	..	..	4	1					
26-26¾	61	8	8	10	2	2	2	..	..	..	..	3						
27-27¾	57	3	2	5	4	4	..	1	1	..	..	4	..	..	1			
28-28¾	49	1	6	5	4	1	..	..	..	..	..	..	..	..	..	..	1	
29-29¾	53	5	3	7	..	3	1	..	..	1	..	1	..	..	..	..	1	
30-30¾	53	..	3	7	2	..	1	..	..	..	..	3	..	..	..	..	..
31-31¾	30	3	1	4	1	..	..	..	..	..	..	..	..	..	..	..	1	
32-32¾	33	..	..	6	5	..	2	..	..	..	..	1	..	..	..	..	..
33-33¾	29	1	..	4	3	..	3	1	..	..	..	..	..	..	..	..	..	1
34-34¾	37	..	..	8	3	..	4	..	..	1	..	1	..	..	..	..	..
35-35¾	25	..	..	5	..	..	2	..	..	..	..	1	..	..	..	1	..	2
36-36¾	15	1	..	3	2	..	2	..	1	..	..	..	..	..	..	1	..	1
37-37¾	20	..	..	5	4	..	1	..	..	..	..	..	..	..	..	..	..	2
38-38¾	8	1	..	1	3	..	..	..	1	..	..	..	..	..	..	..	..
39-39¾	6	..	..	2	1	..	..	..	..	..	..	..	..	..	..	..	..
40 and over	4	..	..	1	..	..	..	..	..	..	..	1	..	..	..	..	..
		370	221	85	59	52	18	4	4	2	1	2	31	8	6	4	4	7

Where no figures are given, "0" is intended. It has been omitted in order to facilitate reading the table especially where organisms only occurred once or twice.

TABLE 2.—SHOWING THE MONTHLY DISTRIBUTION OF THE VARIOUS TYPES OF ORGANISMS RECOVERED.

Month.	Frequency of Occurrence.														
	Main Food of Stockfish.						Other Organisms Found.								
	Mysids and/or Euphausiids.	<i>Myxolophum</i> and/or <i>Maurolicus</i> .	<i>Merluccius capensis</i> (Stockfish).	Macrurids (mostly <i>Coelorhynchus fasciatus</i>).	Cephalopods (mostly <i>Loligo</i> sp.).	<i>Trachurus trachurus</i> (Masbankers).	<i>Scomber colias</i> (Mackereel).	<i>Photichthys argenteus</i> .	<i>Helicolenus maculatus</i> (Sancord).	<i>Tripterygopsis gilchristi</i> (Gilchrist's Triple-fin).	<i>Sebastesomus</i> (Jacopever).	Fish remains (unidentifiable).	<i>Solenocera</i> or <i>Funchalia</i> (Prawns).	Prawn-like crustacean remains (unidentifiable).	<i>Parapagurus dimorphus</i> (Hermite Crabs).
															Starfish or Polychaeta.
1942 August	5	1	3	1	..	2	..	..	..	..	..	5	..	..	1
September	32	15	6	5	2	1	..	1	..	..	..	2	..	..	..
October	8	8	4	2	2	4	..	..	..	..	..	3	..	..	..
November	29	21	7	6	7	2	..	..	..	..	2	2	1 F* 1 S*	..	..
December	59	14	4	4	2	..	..	..	..	..	..	4	1 S	..	..
1943 January	26	18	2	2	8	..	..	..	..	..	..	1	1 S 1 F	..	..
February	48	40	1	5	10	..	..	..	..	1	..	1	..	1	..
March	24	16	3	2	10	..	1	1	..	..	..	3	2 F	1	..
April	12	9	4	..	..	..	..	..	..	..	..	..	..	..	..
May	29	16	7	4	3	..	1	..	1	..	..	1	..	..	..
June	18	13	7	1	..	..	1	..	..	..	..	1	..	..	..
July	14	16	6	2	2	1	..	..	..	..	..	1	..	..	2
August	16	11	6	10	4	1	..	..	..	..	..	3	1 F	..	1
September	6	0	5	4	..	2	..	..	1	..	..	3	1 S	..	..
October	32	16	7	4	..	2	1	1	..	..	..	..	..	1	..
November	4	5	7	5	2	..	..	..	..	..	..	1	..	..	..
December	7	1	5	1	1	1	..	..	..	..	..	..	..	1	..
1944 January . . . . .	..	1	1	1	1	1	..	..	..	..	..	..	..	..	1

* F=*Funchalia*; S=*Solenocera*.

As will be seen from Table 1 the type of food found in the stomachs varied to a large extent with the size of fish. For convenience, therefore, fish from 10 to $17\frac{3}{4}$ inches in length were ranked as small, those between 18 and $30\frac{3}{4}$ inches as medium, and fish 31 inches and over as large. Fish below 10 inches in length were rarely encountered so that it was not possible to ascertain to any great extent what constituted the main food of these very small fish.

Before discussing each item of food separately it should be pointed out that the South African stockfish appears to be very similar in its habits to the European hake in that it feeds by night, presumably some distance from the bottom, and is only caught by the trawl during the day when it goes back to the bottom again. The fish from which the data for this paper were obtained were usually brought up in the last trawl of the day before returning to port, *i.e.*, between 2 p.m. and 3 p.m. To what extent the types of food found in the stomachs of these fish would have varied had they been caught in the early morning has not been ascertained.

The principal food constituents of the stockfish in order of importance are: small crustacea belonging to the *Mysidacea* and *Euphausiacea*, small deep-sea fish belonging to the *Myctophidae* and *Stomiidae*, small specimens of *Merluccius* (stockfish), *Macrurids*, *Cephalopods*, and to a lesser extent *Trachurus* (masbanker or horse mackerel). Of the other organisms listed in the table only the prawn-like crustacea, represented chiefly by the two genera *Solenocera* and *Funchalia*, may possibly form a minor constituent of the diet, the rest occurred far too spasmodically to be regarded as important.

Mysidacea and Euphausiacea.—These small pink crustacea formed a very large part of the food of fish up to about 30 inches in length but fish larger than this do not appear to feed on them at all, only single specimens being found when they did occur in the stomachs. The mysids were usually species of *Thysanopoda* and the euphausiids species of *Euphausia*, but identification was often difficult on account of the mutilation which had taken place and no attempt was made to determine the species.

According to Smith (5) the *Mysidacea*, although pelagic, are not very frequently found on the surface but generally swim some distance below it, going down in many cases to the abysses, while the euphausiids, on the other hand, are frequently met with in the surface plankton, one species *E. pellucida* being taken at the surface as well as at considerable depths. Hickling (6) says that the euphausiids, which form the main part of the food of small hake, have a very

definite habit of swimming up to the surface at night and sinking to the bottom or to considerable depths by day. There is no available information regarding this vertical migration as far as the South African euphausiids and mysids are concerned, but in view of the fact that the stockfish leave the bottom at night to feed in the higher strata it is possible that these crustacea also rise from the bottom to the middle depths at this period, unless of course they frequent them all the time. That they are present in midwater at the time of feeding is obvious, but how far they extend towards the surface is a matter of conjecture. Hickling says that small hake feed directly on these euphausiids and must clearly follow them to the surface. The small stockfish, *i.e.*, those between 10 and 18 inches in length, also feed heavily on them, but if the crustacea rise right to the surface at night and the small fish follow them, then the medium, and particularly the large, stockfish will be found at the surface as well, in order to obtain the small stockfish which in turn form such an important item in their diet. It is unlikely that stockfish of all sizes feed at the surface in this manner, and it seems more probable that only the very small stockfish, *i.e.*, those under 10 inches, will be found there, and thus account to a certain extent for the extreme rarity with which fish of this size are found in the stomachs of the larger fish. It therefore appears that the small- and medium-sized fish remain in the middle waters where the crustacea abound freely and that the large fish either remain in still deeper waters where few crustacea occur, or if they do come up to midwater they show great discrimination in their selection of food. Other deep-sea fish such as *Coelorhynchus*, *Maurolicus* and *Myctophum* as well as the pelagic species *Trachurus* also feed heavily on these crustacea.

Several attempts were made to ascertain the food of these mysids and euphausiids, but apart from a few diatoms of the *Coscinodiscus* type nothing recognisable was recovered from their alimentary tract.

Myctophidae and *Stomiatidae*.—These two families were represented by the genera *Myctophum* and *Maurolicus* respectively and are classed together, as in the majority of cases they were found in a semi-digested condition making identification difficult. The presence of photophores characteristically arranged on pieces of skin, and also the otoliths, assisted materially in recognising these two genera when the bodies were often considerably digested. They are small deep-sea fish usually about $1\frac{1}{4}$ – $1\frac{3}{4}$ inches long, and were nearly always found together with the small crustacea. They form a large part of the food of fish up to about 30 inches in length throughout the year, but

fish above this length do not feed on them at all. When these small fish are in abundance as food, as many as 77 have been found in one stomach. It is interesting to note that it was on this occasion when the stockfish had been feeding more heavily than usual on the small fish, that the latter in turn were found to have been feeding on copepods (*Calanus* sp.). This occurred towards the end of February 1943 and was the only time that copepods were found as food—the mysids and possibly euphausiids being the only other food encountered in the stomachs of these small fish.

Myctophum cocci (Cocco) and *Maurolicus pennanti* (Walb.) were the two species commonly encountered, but *Myctophum humboldti* (Risso) was also found on a few occasions and it is possible that other species may have been present but were too badly mutilated to allow of identification. Barnard (1) has described a new species of *Myctophum* (*M. aeolochrus*) as having been found in the stomach of a stockfish.

Merluccius capensis Cast. (Stockfish).—These were found in the stomachs all the year round and form the main diet of the large fish. They were recovered from fish 18 inches in length and upwards but were more common in fish above 24 inches. They were not found in the stomachs of any fish below 18 inches in length. The size of the stockfish found as food varied between 4 and 21 inches. Of those still measurable 3 were below 10 inches, 45 between 10 and 15 inches, and 14 between 16 and 21 inches. The rarity with which fish below 10 inches were found in the stomachs has been mentioned in a previous section of this paper and is interesting in that it indicates that the South African stockfish apparently follows to some extent the same habits as the hake during the first two years of its life. The available data (4) on the rate of growth of the stockfish during the first few years of its life indicate that it grows about 4–4½ inches a year. Thus at the end of the second year the fish ought to be 8–9 inches long. If these very young fish are similar in their habits to the hake, which according to Hickling (6) remain pelagic for the first two years and only go down to the bottom when they are about 8 inches long, then they will obviously only be found at the surface and therefore not be available as food for the larger fish until they are about two years old or approximately 9 inches in length. On the other hand, even if these very small stockfish do live at the surface during this period, it has still not been established whether they are to be found in the same areas as the larger fish. The hake moves to deeper waters at the commencement of spawning

and gradually migrates to shallower waters as spawning progresses, but the eggs and newly hatched fish, being pelagic, drift considerable distances away from the spawning grounds and it is usually quite a long time before they get back to their usual localities. There is a certain amount of evidence (4) to show that the stockfish also migrates to deeper waters during spawning, but whether the eggs and small fry are carried away by currents and wind and are completely absent from the spawning area until they can fend for themselves has not yet been ascertained.

An interesting point which has arisen in connection with the cannibalism of stockfish is the fact that more males are eaten as food than females. That this is almost inevitable is shown by the greater proportion of males to females in the size group which is eaten by the larger fish. The following table (Table 3) shows the percentage of males which were found among fish under 23 inches in length.

TABLE 3.—SHOWING THE PERCENTAGE OF MALES AMONG FISH UNDER 23 INCHES IN LENGTH.

No. of Fish under 23 Inches Examined.	Per cent. Males.
755	61
* 970	63
* 533	61

* From data supplied by Dr. Roux (4).

Only a small number of stockfish actually taken from the stomachs were examined for sex, but 71 per cent. were males. The male stockfish is obviously a smaller fish than the female and very few of them reach lengths over 23 inches. This is very strikingly shown by the fact that of 683 fish which were over this length only 8 per cent. were males. Fig. 2 shows graphically on a percentage basis the proportion of males to females which were found in the total number of fish examined. As was pointed out earlier, the fish were selected for size and do not therefore constitute a random sample. The fact that they are selected fish may account for the apparently very great preponderance of males over females in the smaller size groups up to about 18 inches. In a random sample this difference is not so

marked although the general shape of the curve is the same, particularly in the biggest size groups.

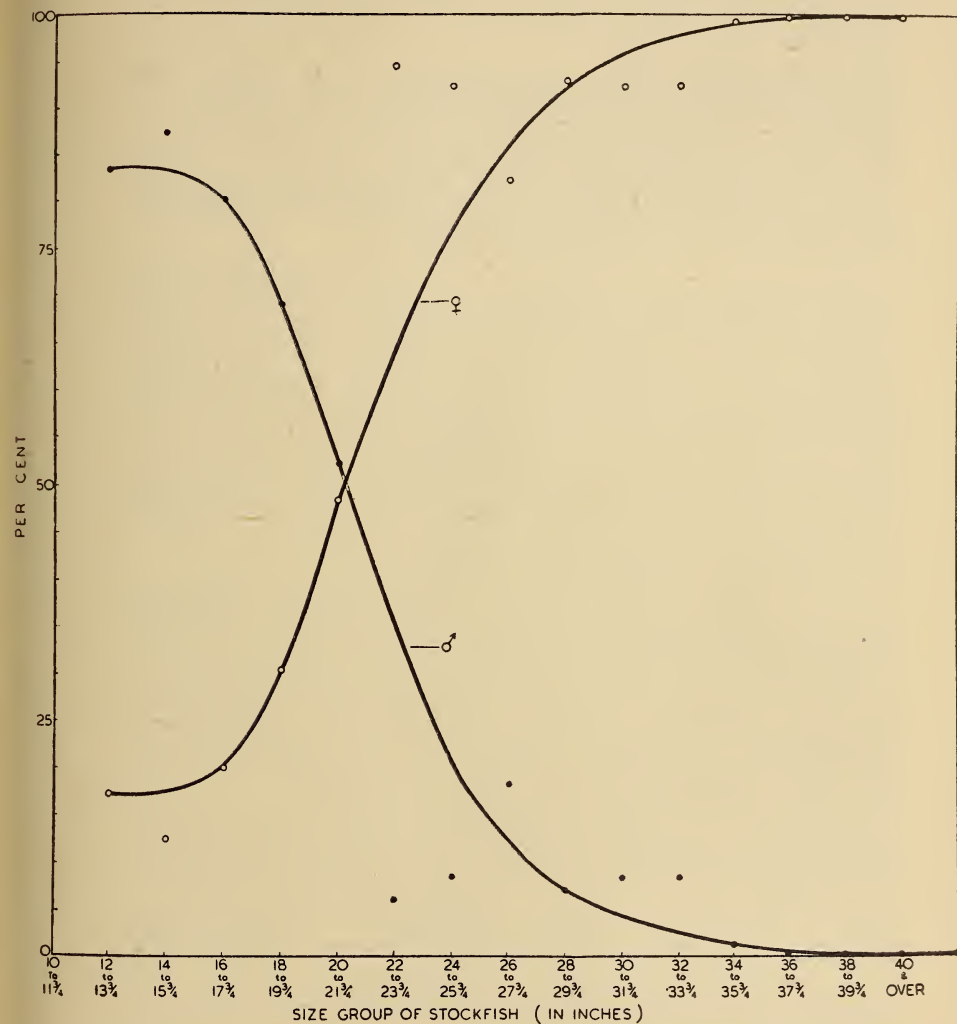


FIG. 2.—Showing the proportion of males to females in the total number of fish examined.

It is difficult to account satisfactorily for the predominance of males in the smaller size groups caught by the trawl or eaten by other fish, but a possible explanation may be that the males congregate sooner than the females.

Macrurids.—It is interesting to note that Hickling (6) states it to be unusual to find bottom-living fish such as the Macrurids in the real food of the hake. Gilchrist (2) however, in reference to the stockfish, says that it was

“ . . . found by the ‘Pickle’ in great abundance in the deeper waters up to 300 fathoms, and, occasionally, even in 500 fathoms. Its presence in deeper water is explained by the fact that it seems to feed almost exclusively on *Macrurus fasciatus*, which is so abundant in these regions, and a glance at the list of fishes, etc., procured, published in the first Report of the Survey, will show how constant is the association of the two fish in the catches.”

During the present investigation Macrurids were certainly found to form part of the diet of stockfish, but were by no means the chief constituent. The stockfish examined, however, were trawled at depths of about 150–200 fathoms and their food may of course be different from that of the stockfish frequenting the very deep waters up to 500 fathoms. *Coelorhynchus fasciatus* (Gnthr.) was the commonest Macrurid encountered. It occurred all the year round and was eaten by fish from 17 inches and upwards in length, but not by the smaller fish, although the rat-tail itself was sometimes only $2\frac{1}{4}$ to 6 inches long, the longest being $18\frac{1}{2}$ inches.

As the Macrurids are essentially bottom dwellers—a study of their food (Table 4) shows that they feed mostly on or near the bottom—it is of course possible that they mainly frequent the depths in which the larger stockfish occur and thus are more likely to become the prey of these fish. On the other hand the fact that copepods (*Calanus* sp.) were eaten in quantity by small rat-tails at one stage shows that they do feed near the surface on occasions.

Cephalopods.—In a large number of cases only the eyes and horny mandibles were found in stockfish stomachs, but when specimens in an identifiable state were recovered they were almost invariably a species of the decapod *Loligo*. These varied in size from 4 to 18 inches and were present practically throughout the year, being in greatest abundance in 1943 during January to March. They formed an important constituent of the food of the medium-sized fish, only two being found in fish below 18 inches in length and none in fish over 30 inches. *Loligo* is pelagic and moves about in large shoals so that it would appear to be available as food for all sizes of stockfish. It is therefore curious that only the fish of the medium-sized group seem to favour it as food. Whether such a fact has any biological significance in South African waters is a matter of conjecture, as

TABLE 4.—FOOD OF MACRURIDS (MOSTLY OF
COELORHYNCHUS FASCIATUS).

Month.	Contents.
August 1942 .	4 specimens of <i>Squilla armata</i> , and crustacean remains, some probably of <i>Squilla</i> ; 1 sponge crab (<i>Exodromidia spinosa</i>); 2 <i>Polychaeta</i> ; 2 dragonets (<i>Paracallionymus</i> sp.); unrecognisable fish remains.
September 1942 .	Remains of a fish (probably stockfish).
October 1942 .	Numerous <i>Thysanopoda</i> , several specimens of <i>Eunice aphroditois</i> .
November 1942 .	..
December 1942 .	Several specimens of <i>Eunice aphroditois</i> and prawns (<i>Squilla</i> sp.)?
January 1943 .	1 Isopod; 1 <i>Polychaete</i> ; 1 mysid; 1 starfish.
February 1943 .	Very numerous mysids; 1 <i>Maurolicus</i> ; 1 euphausiid; 1 <i>Polychaete</i> ; 1 hermit crab, probably <i>Eupagurus</i> sp., and remains of several small fish.
March 1943 .	Numerous hermit crabs (<i>Eupagurus</i>); several mysids; 3 specimens of <i>Eunice aphroditois</i> ; 1 <i>Pandalina brevis</i> ; and crustacean remains probably <i>Squilla</i> ; 1 <i>Polychaete</i> .
April 1943 .	..
May 1943 .	1 sponge crab (probably <i>Exodromidia</i>); several hermit crabs; 2 <i>Polychaeta</i> ; crustacean remains and fish remains, both unidentifiable.
June 1943 .	Remains of cephalopod; remains of stockfish.
July 1943 .	2 Dragonets; 4 mysids; several hermit crabs; 7 <i>Polychaeta</i> ; remains of 4 cephalopods; 3 specimens of <i>Squilla</i> and remains of crustacean, probably <i>Squilla</i> ; remains of several small fish (1 of which probably stockfish; 2 of which probably <i>Maurolicus</i>); remains of 2 small crabs (probably sponge crabs).
August 1943 .	Numerous copepods (<i>Calanus</i> sp.); 3 <i>Polychaeta</i> , several hermit crabs (<i>Eupagurus</i> sp.); 3 specimens of <i>Eunice aphroditois</i> ; 1 <i>Loligo</i> , and remains of several small cephalopods; very numerous portions of red starfish; 3 <i>Maurolicus</i> ; several <i>Thysanopoda</i> ; 9 <i>Leontocaris paulsoni</i> ; 1 stockfish.
September 1943 .	..
October 1943 .	Gorged with <i>Thysanopoda</i> .
November 1943 .	..
December 1943 .	..
January 1944 .	Several <i>Squilla</i> ; 3 cephalopods; 1 <i>Eunice aphroditois</i> ; remains of <i>Maurolicus</i> or <i>Myctophum</i> .

cephalopods apparently form an important part of the food of all sizes of the European hake, except of course the very young fish. No recognisable food remains were recovered from the alimentary tract of the cephalopods.

Trachurus trachurus Linn. (Masbankers, Horse-mackerel).—Masbankers, although not found very frequently, were recovered mostly from the stomachs of the large stockfish, *i.e.*, those over 30 inches in length, none being found in fish below 26 inches. From the present data masbankers do not appear to be available as food from January to June but further observations are required to confirm this. In this connection, however, it is interesting to record that Kallir, Rapson and Schwartz (7), during a study of the variations in oil content of the masbanker, found difficulty in obtaining trek-net fish during the latter half of the year, and they suggest that a migration may take place at this time, away from the coastal waters in which they are usually caught, possibly for spawning purposes. If the masbanker migrates to deeper waters, then it could become available as food for the stockfish during the latter half of the year and be absent from their feeding grounds during the first half.

Two masbankers 13 inches and 14 inches long, taken from a stockfish in July, were examined and their stomachs found to contain numerous mysids and a few specimens of *Maurolicus* as well, while masbankers examined from other sources were found to feed fairly frequently on Mysidacea (*Thysanopoda* sp.) and on one occasion the stomachs were gorged with *Mesopodopsis slabberi* van Beneden.

OTHER ORGANISMS FOUND IN THE STOMACH OF THE STOCKFISH.

Several other organisms were found in the stomachs from time to time, which, although not forming part of the regular diet, are listed here mainly for purposes of distribution records.

(a) Prawn-like Crustacea. The badly mutilated remains of red prawn-like crustaceans were found several times in the stomachs, and when whole specimens were recovered they were identified as *Solenocera* sp. (probably *S. siphonoceras*) and *Funchalia woodwardi* Johnson. On one occasion 18 of the latter were found in one stomach and 12 in another. It is interesting to note that several adult males of *F. woodwardi* were present among these specimens and are the first to be recorded from South African waters.

(b) *Photichthys argenteus* Hutton, a deep-sea fish, which, like *Maurolicus*, belongs to the family *Stomiidae*, was found on four

occasions but the presence (at other times) of pieces of skin with photophores similar to *Photichthys* suggest that it may have been eaten more frequently.

(c) *Scomber colias* Gmel. (Mackerel). These fish were recovered from the stomachs of stockfish only four times throughout the year, which is surprising as they are said to occur in large shoals together with masbankers.

(d) *Jacopever*. Five small (about 1-1½ inches long) and very young specimens of either the ordinary *Jacopever* (*Sebastichthys*) or the Spiny *Jacopever* (*Sebastes*), probably the latter, were found in a good state of preservation and were obviously freshly swallowed. They were taken from two stockfish stomachs in December. The stomachs of these young fish were gorged with Mysidacea.

(e) *Helicolenus maculatus* (C. and V.) (Sancord). Two obviously freshly swallowed specimens were recovered in May and September. One of them had been feeding heavily on Mysidacea.

(f) *Tripterygius gilchristi* Blgr. (Gilchrist's Triple-fin) was found once in February.

(g) *Parapagurus dimorphus* (Studer) (Hermit crabs), large red Sea-anemones, and Starfish were found several times and on one occasion a *Polychaete*; most of these were obviously freshly swallowed.

COMPARISON OF THE FOOD-CYCLE OF THE SOUTH AFRICAN STOCKFISH WITH THAT OF THE HAKE OF EUROPEAN WATERS.

Unfortunately the Fisheries Investigations Reports (Nos. 1 and 2 of vol. x, Series II) of the British Ministry of Agriculture and Fisheries, wherein Hickling describes in detail the food of the hake, are not available in this country, and all the references to the hake throughout this paper have been taken from "The Hake and the Hake Fishery" which are his Buckland Lectures for 1934 published in book form. However, for purposes of a general comparison sufficient data are available and the following charts (see page 328) of the food-cycles of the two fish show the essential features fairly clearly.

In the case of the stockfish the initial links in the food chain have not yet been established, but it is reasonable to assume that, following the cycle of the hake, copepods feed on some plankton organisms such as diatoms, and that very young stockfish, mysids and euphausiids feed on copepods. The identity of the small fish mentioned by Hickling which form an important part of the food of small hake,